

NIST Uses Inkjet Printing Technology to Produce Standards for Trace Level Explosive Analysis

NIST is developing a procedure to produce standards for trace explosive analysis using inkjet technology. Homeland security priorities have led to the unprecedented deployment of trace level explosive detection systems for counter terrorism purposes, all requiring calibration. It is estimated that tens of thousands of ion mobility spectrometry (IMS) based instruments are now deployed at airports, seaports, embassies, national monuments and at government and military facilities worldwide.

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Measurement standards are needed to calibrate ion mobility spectrometers (IMS) and optimize their performance. Since standards are consumed during IMS analysis, any standards production method must be capable of producing large quantities of standards quickly and inexpensively. To achieve this we are investigating piezoelectric drop-on-demand inkjet printing technology. Piezoelectric inkjet printing is a rapidly expanding technology with diverse applications ranging from the printing of microelectronics to the printing of DNA arrays and tissue engineering. Inkjet printing potentially offers a flexible, rapid and reproducible method for the preparation of explosive standards. These standards can be printed onto a variety of substrates ranging from paper to floppy disks to luggage handles. For standards production, a large dynamic range (10^5) in explosive concentration on the printed standards can be achieved from a single standard solution simply by changing the number of droplets printed.

NIST has used a piezoelectric inkjet printer to print a variety of “on-demand” explosives calibration standards including TNT, RDX and PETN, as well as plastic explosives such as C4, Semtex and Detasheet.

A pilot study is underway to evaluate the performance of currently deployed IMS instruments and gain insight into lifetime issues that exist with explosive standards. In this pilot study, prototype standards of C4 explosive were produced using inkjet printing and issued to the U.S. State Department for distribution and testing at U.S. embassies. Additional explosive standards were produced for evaluation by the Transportation Security Laboratory, the National Institutes of Health and NIST.

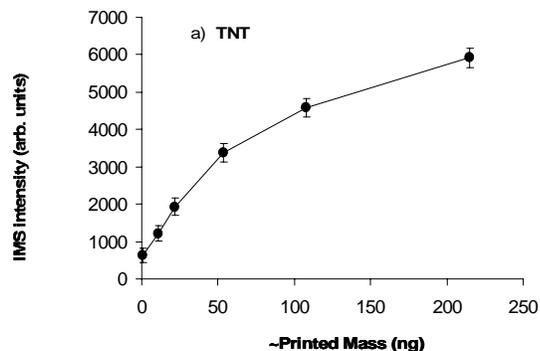
Future Work: Future work will include the investigation of methods to improve the lifetime of these semivolatiles explosive standards. Methods under consideration include experimentation with different packaging techniques, and methods to encapsulate the explosive including the incorporation of a polymer into the printing solution or the use of surface alteration techniques to encapsulate the explosive.



C4 Prototype standard sheet containing 10 consumable standards.



Fluorescence microscope image of inkjet printed array



IMS response curve for inkjet printed prototype TNT standard